Veterinary Medical Research: The Cornerstone For Healthy Life

Association of American Veterinary Medical Colleges and Cooperative State Research Service, U.S. Department of Agriculture

May 1988

On the cover. . .

Horses provide pleasure for millions of Americans and provide the basis for the $2.7 billion U.S. racing industry. (Photo courtesy of Michigan State University)

Veterinary Medical Research: The Cornerstone For Healthy Life

Veterinary medicine touches almost every critical aspect of human life—from the food we eat and the clothes we wear, to our physical, emotional, and economic well being and the quality of our environment. Thus, research to advance the frontiers of veterinary medicine is fundamentally important to healthy life.

Among the most critical challenges humans face today are to provide enough safe food, combat disease, ensure environmental quality, and promote a society in which humane values prevail. Americans demand continuing efforts from veterinary medical research to meet these challenges.

Malnutrition is the leading cause of human illness around the globe. Veterinary medicine is helping feed a hungry world by reducing livestock losses from disease and parasites, advancing a better understanding of human and animal nutritional needs, and improving the efficiency of food production.

Infectious diseases cause human death and suffering, as do genetic and environmentally induced diseases. Veterinary medicine—through basic biomedical research, the study of zoonoses, and the application of animal models for human disease—contributes to the search for improved prevention, treatment, and cure of these diseases.

(Continued on page 2)

Animals play an integral role in human life, providing food, fibers, transportation, protection, and companionship. (Photo courtesy of Cornell University)

Veterinary medicine often deals with populations of animals, a dimension that has direct implications for public health. The epidemiologic approach to disease studies was pioneered with animal populations. Moreover, both public health and veterinary medicine use cost-benefit analyses to deliver the maximum health care with limited economic resources.

Veterinary medicine is concerned with maintaining and enhancing the health of the three fundamental components of the Earth's ecosystem: people, animals, and the environment.

Food safety was an early concern of veterinary scientists and continues to be an important environmental health aspect of the profession. More recently, great potential has been recognized in monitoring, through domestic and wild animal populations, the biological risks to humans of environmental contaminants.

The vital role nonhuman animals play in promoting human health also has become increasingly apparent in recent years. Long concerned with the health and well-being of companion animals, veterinarians now are also turning their attention to the ways in which such animals enhance the physical and mental well-being of their human companions.

Thus, veterinary medicine is concerned with maintaining and enhancing the health of the three fundamental components of the Earth's ecosystem: people, animals, and the natural environment. Veterinarians have been viewed traditionally as dealing solely with the diseases of companion animals and livestock. In reality, they have long been involved in the quest to eradicate human disease and, more recently, in the effort to protect our environment. Indeed, veterinary medicine serves not only as the medical arm of agriculture, but also as the foundation for human medicine and the sentinel of environmental protection. Expanded research in all these areas is essential if veterinary medicine is to build on this cornerstone for healthy life.

The Integral Role of Animals

Animals are interwoven so intimately in human life that it is almost impossible to imagine a world without them. From the dawn of civilization, animals have provided companionship, food, clothing, transportation, and protection for human society.

The unique, almost symbiotic, relationship between humans and dogs dates back 14,000 years. Today, there are about 65 million dogs in the United States alone, along with 60 million cats, 7 million horses, 45 million pet birds, 75 million small caged mammals and reptiles, and untold millions of tropical fish. The companionship and unconditional love these animals provide is a vital antidote to the stress of today's highly mobile, goal-oriented society.

Wild animals were the principal source of food for early hunting cultures. By 12,000 BC, man had established a cooperative hunting society with dogs, which led to the domestication of sheep and goats and the beginnings of animal agriculture. Today, animals account for 12 to 35 percent of our worldwide dietary protein needs, and animal protein contains 100 percent of the essential amino acids. In the United States, about 35 percent of the energy and 67 percent of the protein in our diet comes from animals and their products.

There are approximately 169,398,000 food animals (not including poultry) in the United States today. About half of U.S. agriculture's annual income—$72.7 billion—comes from livestock and livestock products, and a majority of our nation's grain crop is used for animal production.

Animal hides provided early man with his first protective clothing. In modern societies, leather, wool, and other natural fibers continue to be the products of choice for shoes, clothing, and household furnishings.

For centuries, the horse was the fundamental mode of transportation, the means for cultivating crops, and

About 67 percent of the protein and 35 percent of the energy in U.S. diets comes from animals and their products. (Photo courtesy of the University of Georgia)

the essential tool for military conquest. Today, the use of animal power still exceeds mechanical power worldwide. In developed societies, horses provide recreation and entertainment for millions of people and form the basis of a $2.7 billion racing industry in the United States alone.

The role of animals in protecting humans ranges from watchdogs on the farm to the frontiers of biomedical science. Animals always have been, and continue to be, vital to a better understanding of the human body and essential in the fight against human disease (see box on page 5). Without the aid of animals in research, humans would not have vaccines and antibiotics, while many medical and surgical techniques could not have been developed. Today, animal populations also play an important role in protecting humans and the environment from chemical and other contaminants.

There are 65 million dogs, 60 million cats, 7 million horses, 45 million pet birds, and 75 million small caged mammals and reptiles in the U.S. today. Moreover, half of American agriculture's annual income—$72.7 billion—comes from livestock and livestock products.

Because animals are an integral part of human life, we have the responsibility to ensure that they are treated humanely and respectfully. This responsibility takes many forms:

- educating pet owners about the health requirements of their animals and the need to reduce the births of unwanted, abandoned—and ultimately euthanized—dogs and cats.
- developing improved livestock production methods to use the animals' natural environmental and behavioral requirements to minimize stress and the need for synthetic additives.
- promoting the protection of endangered species through enforcement of strong legislation and funding of population recovery programs.
- ensuring the humane treatment of animals in biomedical research, minimizing the number of animals used, and protecting them from unnecessary pain and suffering.

Millions of kids in the majority of American families learn responsibility through caring for pets and enjoy the unconditional love of their animal companions. (Photo courtesy of Oklahoma State University)

Veterinarians play a vital role in these efforts. Because they have a unique understanding of animals and their needs, veterinarians also have a special responsibility to educate others about the health and well-being of animals. They provide leadership in promoting animal welfare in all phases of human-animal interactions, including the humane treatment of animals used in research.

Historical Roots of "One Medicine"

The historical roots of veterinary medicine's pivotal role in human health date back to the animal-centered cultures of ancient eras. Sacred Egyptian texts from 4,000 to 300 BC suggest that comparative medicine began in the Nile Valley. The early Greeks were the first to systematically use this approach to better understand human anatomy and physiology, thus establishing the precedents for the practice of human medicine.

From these early beginnings, the ancient "one medicine" soon branched into a medicine aimed at humans and one assigned to all other animals. However, because of religious prohibitions against defiling human bodies, medical practitioners continued to rely on veterinary observations and experiments as the basis for their science. It was not until the dissections of Vesalius—only 400 years ago—that human medicine began to acquire its own anatomical and physiological foundation.

A French veterinarian, Jacques de Solleysel, opened a new era in medical science with his experimental transmission of glanders from one horse to another in 1664. In the early 18th century, epidemic cattle diseases, such as Rinderpest, anthrax, and foot-and-mouth disease, resulted in the establishment of the first colleges of veterinary medicine at Lyon (1762) and Alfort (1765).

These French veterinary colleges, and those that followed in other European countries, produced medical investigators who began a revolution in medical science. Edward Jenner demonstrated the value of veterinary medicine to human health through his studies of animal diseases and livestock sanitation. Claude Bernard investigated normal animal functions and refined systematic experimentation as an approach to biological science. Henri Toussaint first cultivated the fowl cholera microbe *in vitro* and demonstrated the efficacy of attenuating the anthrax bacillus.

Jean-Baptiste Chauveau, of the veterinary faculty in Lyon, did pioneering work in cardiology and vaccination before he began his fundamental studies of immunity. Gaston Ramon, a veterinarian at the Pasteur Institute, later discovered the principle of toxoids and developed the ones used against tetanus and diptheria. Other medical giants of the time— Pasteur, Virchow, and Koch—relied on animal studies for many of their seminal breakthroughs.

Similar interactions between human and veterinary medicine were at work in North America. Sir William Osler, founder of the innovative medical school at Johns Hopkins University, had valuable associations with veterinary researchers throughout his productive career.

America's best-known research physician of the turn of the century, Theobald Smith, spent virtually his entire career in veterinary medicine, isolating the first *Salmonella* bacterium and studing the immunizing value of heat-killed bacteria. He worked with Daniel Salmon, who, as director of the Bureau of Animal Industry, eradicated from the United States such diseases as contagious bovine pleuropneumonia. He also successfully demonstrated the efficacy of population-based control techniques.

Contemporary Veterinary Medical Research

From its early contributions to human health (see box on page 5), veterinary medicine has grown to be a crucial partner in a unified approach to biomedical research. Today, veterinary medical research is a complex scientific enterprise responding to a vast array of economic, biological, and societal needs. The scope of its investigations is virtually unlimited, potentially involving every species of animal life: microscopic organisms that cause disease; insects and other invertebrates that carry diseases; fish, birds, and mammals—both wild and domestic—that provide food and fibers; companion animals and wild species that enhance the quality of life; and humans themselves. This foundation in comparative medicine—the ability to detect critical differences among species as well as similarities—is one of the profession's greatest assets in placing humans, animals, and the environment in a single context.

In addition to this breadth of species, veterinarians work with different quantities of animals, ranging from the individual to entire populations. Veterinary scientists may investigate the relationships between a single pet and its elderly owner, use a species of animal to study a disease that afflicts a limited number of people, or work with herds or flocks of livestock or poultry to help feed entire human populations.

Figure 1.

The Dimensions of Veterinary Medical Research

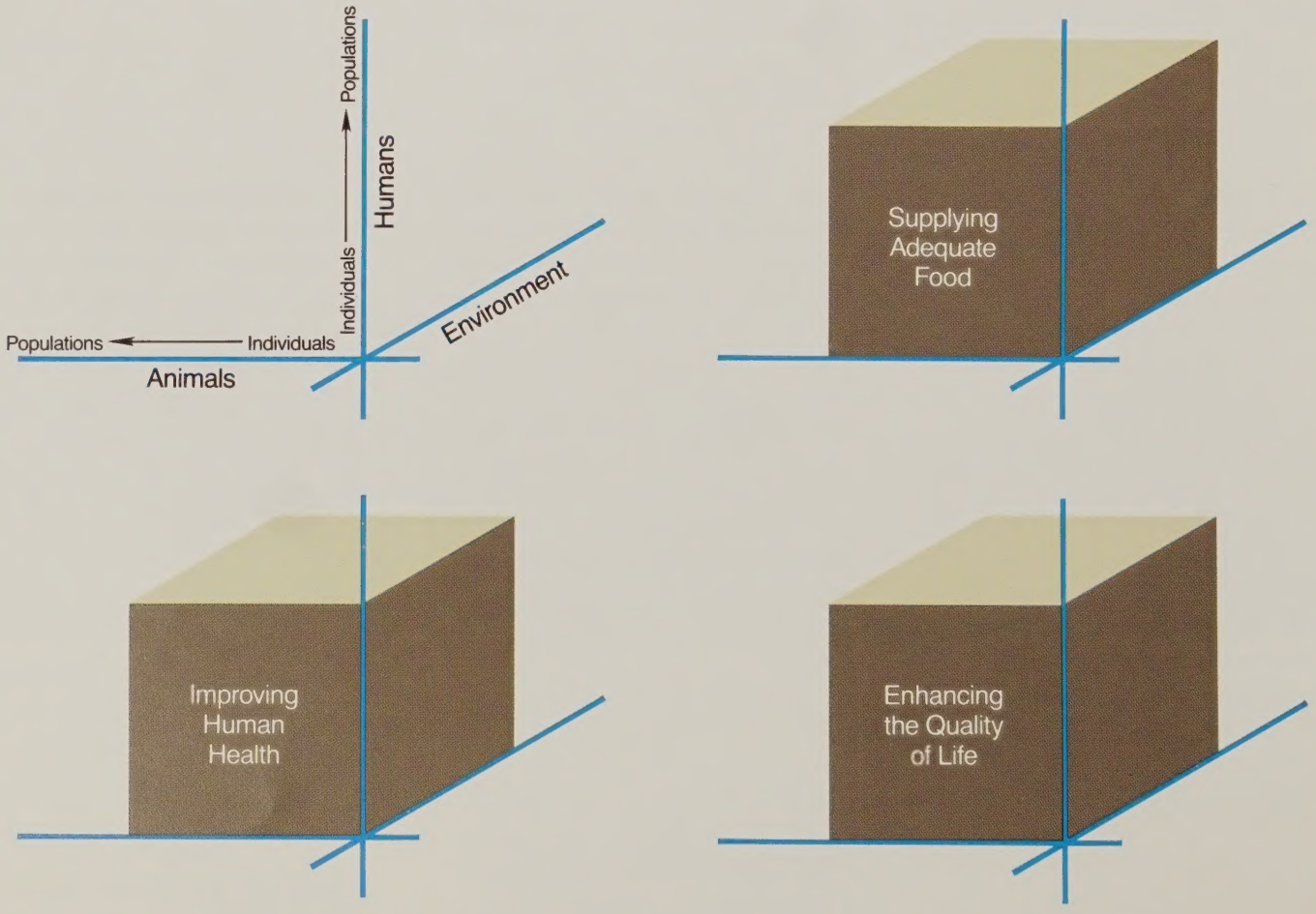
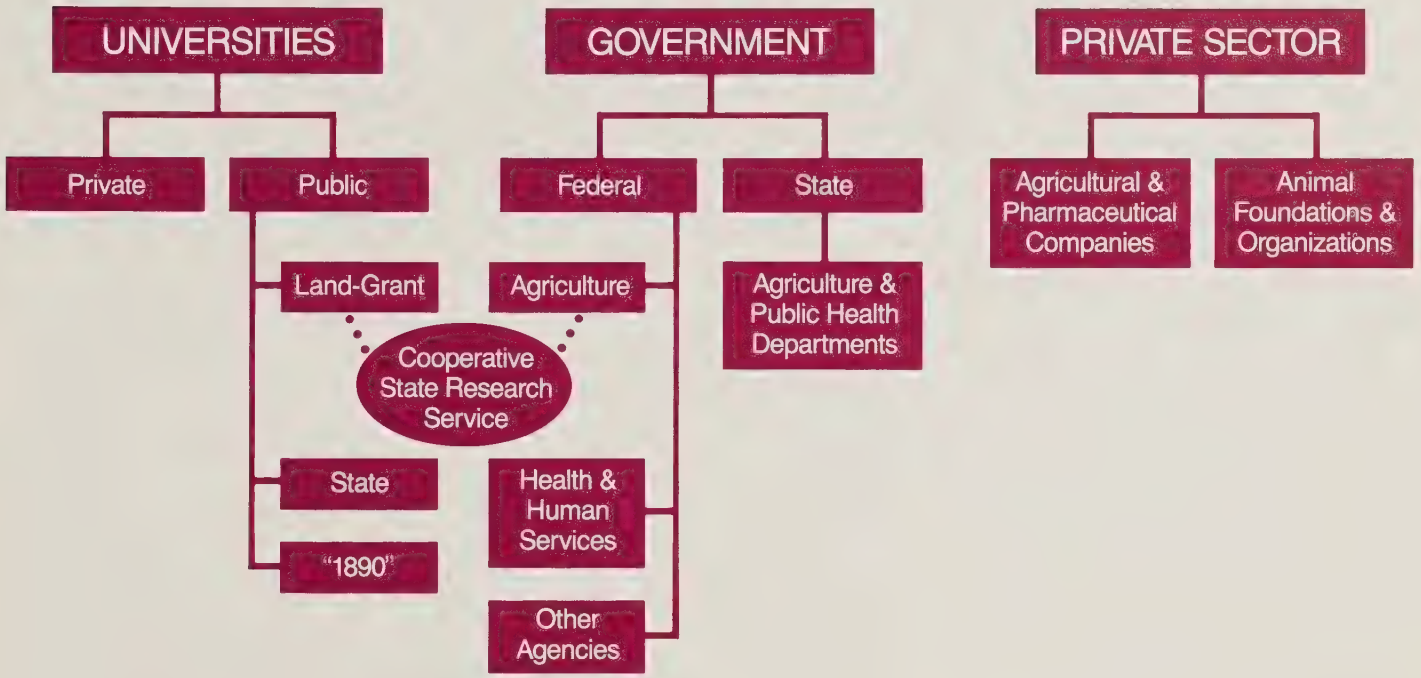


Figure 2.

Organizations Involved in Veterinary Medical Research



Thus, a simplified picture of the structure of veterinary medical research would have three coordinates—humans, animals, and the environment—and each coordinate would range from the individual to the entire population (Figure l). Arrayed within this three-dimensional structure would be the three basic fields of veterinary medical research: food production, human health, and quality of life. These overlapping areas form the cornerstone for healthy life.

To address the many challenging issues within this complex framework, researchers in veterinary medicine come from a variety of educational backgrounds. Most are veterinarians, who bring their multispecies, multidisciplinary medical training to the task, while others are MDs. In both cases, the majority continue beyond their professional degrees for specialty training in one or more of a broad range of scientific disciplines. Still others graduate from traditional PhD programs without prior medical training. All the biomedical sciences are represented —from anatomy to zoology—as are many of the social sciences, including psychology, sociology, and economics. Disciplines such as engineering and computer science also play important roles. Few other professions integrate as many scientific fields as does veterinary medical research.

Veterinary medical scientists offer a strong foundation in comparative medicine, specialty training in a broad range of scientific disciplines, and dedication to solving the practical problems of a variety of clientele.

The integration of these diverse disciplines produces research programs tailored to meet the needs of a multitude of clients, including veterinary practitioners, livestock producers, physicians, companion-animal owners, government agencies, and consumer groups. The scientists involved in these research projects are employed by a variety of public and private organizations (Figure 2).

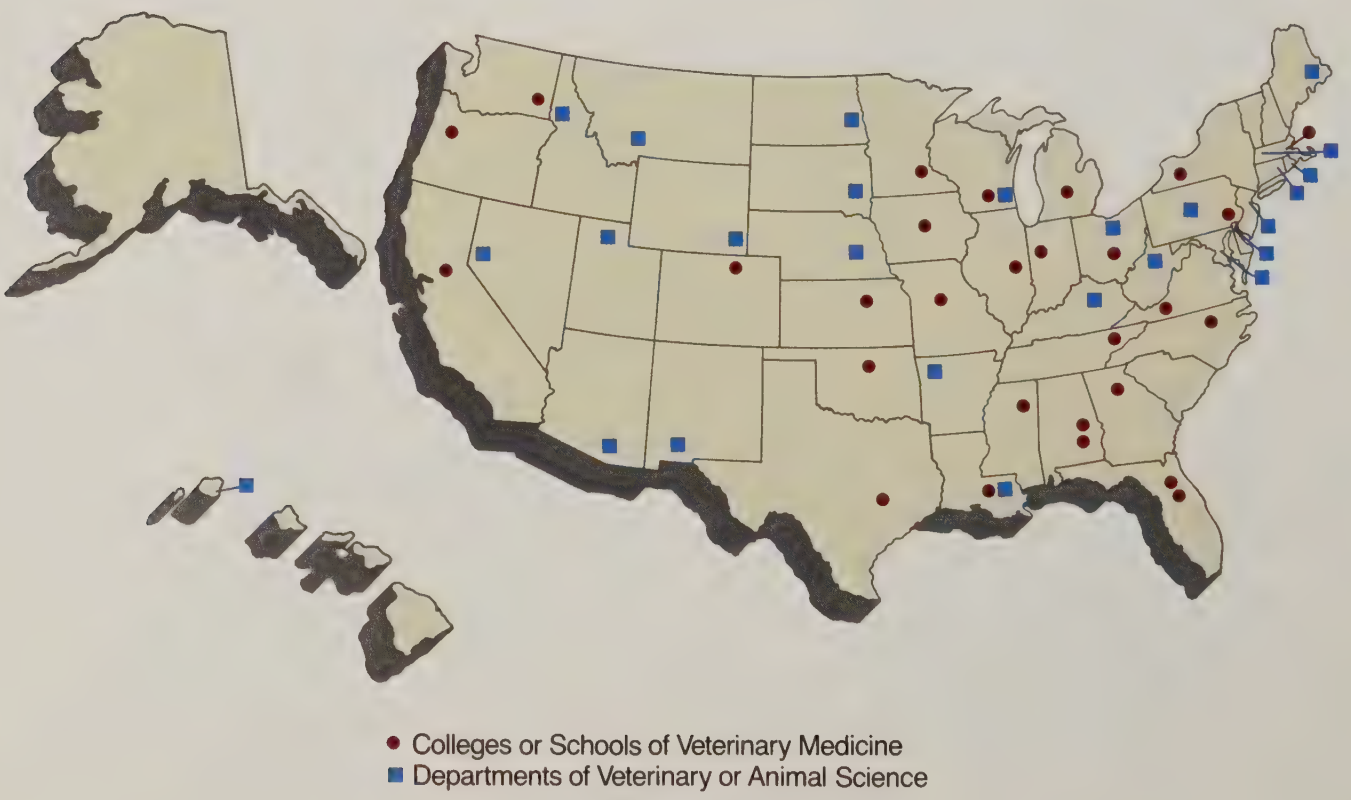
In the public sector, veterinary medical scientists work for federal and state agencies. At the federal level,

veterinary medical research is conducted by scientists at the US Department of Agriculture (USDA), the National Institutes of Health (NIH), and several other agencies. The core of these programs focuses on issues of national or international importance. Many state agriculture and public health departments conduct veterinary medical research designed to solve state and local problems.

In the private sector, pharmaceutical and agricultural companies have scientists working on veterinary medical projects related to product development. Other participants in the veterinary medical research effort include private foundations and research organizations, such as the Animal Medical Center in New York and Angell Memorial Hospital in Boston.

By far the largest portion of veterinary medical research, however, is conducted by university-based scientists, either through colleges and schools of veterinary medicine or veterinary science departments in colleges and schools of agriculture (Figure 3). Investigators at land-grant universities conduct research in a unique and productive partnership with the USDA through the Cooperative State Research Service (CSRS). Many of these research programs are carried out in association with the respective State Agricultural Experiment Stations. Several other state universities, some of the historically black ("1890") colleges, and a few private universities also are involved in veterinary medical research.

Figure 3.
Primary Locations of University-based Veterinary Medical Research



Healthy Ducks, Healthy Kids

Each spring, hundreds of thousands of ducks and geese descend in waves on Lake Andes in eastern South Dakota. They pause for a day, perhaps a week, then continue north to their summer breeding grounds.

But in the spring of 1973, many of them never made it. An estimated 43,000 mallards and 10,000 Canada geese died on the shores of Lake Andes, the victims of duck plague.

"Duck plague is caused by a herpes virus which first occurred in the U.S. in commercial duck farms on the east coast," explains Dr. Tom Yuill, associate dean for research at the University of Wisconsin's School of Veterinary Medicine. "Until 1973, it wasn't recognized as a threat to wild species in North America."

The devastation at Lake Andes, along with a smaller outbreak that year in Wisconsin, prompted wildlife scientists at the University to investigate the disease.

"They found it is caused by different strains of the virus, some more lethal than others," Dr. Yuill reports. "They also discovered there are marked differences in susceptibility among species, with wood ducks and mallards being more susceptible and pintails being resistent."

The scientists determined that long-term crowding, especially in the winter and spring, often leads to outbreaks of the disease. As a result, they were able to develop reasonable response measures to deal with the problem.

Duck plague also galvanized the U.S. Fish and Wildlife Service to establish the National Wildlife Health Research Center in Madison in 1975. Since that time, much collaborative research has been done with the University, and several of the Center's scientists have appointments as adjunct faculty in the Department of Veterinary Science.

"We also collaborate with natural resource departments in Wisconsin and other states," Dr. Yuill says. "We're able to pull together faculty from related disciplines, such as entomology and preventive medicine, to tackle problems."

Wildlife scientists at the University are particularly interested in arthropod-borne diseases, such as La Crosse disease. Named after the town in southwestern Wisconsin where it was first identified, this viral disease is transmitted by mosquitos and causes encephalitis, primarily in children less than six years old.

"We worked out the basic cycle of the carrier—a woodland mosquito that breeds in holes in the base of trees which fill with water," Dr. Yuill reports. "The disease is very opportunistic. Infected females can pass the virus to their eggs. Infected males can pass the virus to uninfected females during mating. And squirrels and chipmunks that are biten by infected mosquitos carry the virus and can pass it on to uninfected mosquitos that later bite them.

"Because this is a virus, there's no treatment for the victims, many of whom must endure long hospitalizations and permanent neurological damage," he continues. "That's why we emphasize prevention—closing up tree holes and removing old tires where the mosquitos breed."

A similar approach now is being taken in the study of Lyme disease by Dr. Betty Burgess. This bacterial disease is transmitted by ticks and causes persistent rash and arthritis in humans and dogs. It is becoming increasingly prevelant in the U.S.

Dr. Yuill and his colleagues are concerned with wildlife not only as reservoirs for diseases that afflict humans and domestic animals, they also are working to protect the wildlife resource itself, as in a recent study by Dr. Ron Schultz of parvovirus in wolves.

Their research also is helping to preserve endangered and threatened species and to protect the environment and all living species from contaminants and pollutants. Their work clearly is an important part of veterinary medicine's foundation for healthy life.

University-based Veterinary Medical Research

Research conducted at the nation's universities is central to the accomplishments of the veterinary medical research community and to the education of tomorrow's veterinary medical scientists. Future breakthroughs in medical science, increases in animal agriculture productivity, and improvements in food safety, environmental quality, and human and animal well-being will continue to rely heavily on university-based research for a variety of reasons.

- Academic research programs have a stable team of veterinary scientists and can draw upon the expertise of scientists in related disciplines. Multidisciplinary academic projects also provide access to a wealth of research facilities and equipment.

Veterinary medical research at the nation's universities offers the advantages of modern facilities, related disciplinary expertise, intellectual stimulation, and rigorous graduate education.

- Extensive library collections, lively intellectual debate, and academic freedom attract many of the nation's best scientists to college campuses and stimulate some of the most productive veterinary medical research. The independence and scholarly credentials of university-based veterinary medical scientists also lend credibility to the results of their research efforts, while graduate education programs provide added depth and rigor to university-based research.
- Research faculty are familiar with the special conditions, issues, and opportunities of their states. Through their professional associations, they also are attuned to veterinary medical applications that are regional, national, and international in scope.
- Most academic scientists participate in effective information- and technology-transfer systems, such as cooperative extension and continuing education programs. Many universities have established research cooperatives that involve industry, government, and/or public representatives in setting research priorities and disseminating results. Others operate research field stations that work directly with livestock producers. These programs ensure the effective flow of useful information to the various clientele of veterinary medical research.

America's 27 colleges and schools of veterinary medicine provide clinical expertise and diagnostic services for the nation's diverse livestock industry. Producers also benefit from research designed to improve productivity and cut losses from disease. (Photo courtesy of Cornell University)

As a result of these special advantages, university-based veterinary medical scientists have made significant contributions to the advancement of human and animal health and well-being. Some recent examples of these advances are described in the research profiles that accompany this text. Today, veterinary medicine stands on the threshold of an exciting new era of research creativity and productivity.

A Veterinary Research Revolution

Scientific research, like most human endeavors, goes through periods of dramatic discoveries and growth followed by longer periods of consolidation, refinement, and application. Most often, it is the development of new technology that leads to scientific breakthroughs and the consequent explosion of new knowledge.

- Advances in microscopes and experimental techniques in the 19th and early 20th centuries led to the microbiological revolution of medicine. This knowledge was applied to help control many of the devastating infectious diseases that had plagued both humans and animals for centuries.
- Use of epidemiologic techniques, developed to prevent and control animal diseases, provided a more comprehensive picture of the causes and occurrences of human diseases, such as cancer.
- Development of sophisticated scientific equipment led to breakthroughs in molecular biology and a better understanding of genetic diseases.
- Creation of the microchip made possible a new generation of computers that could process more data, much faster, which enabled America to land a man on the moon and revolutionized the communications industry.

New Tools

Today, veterinary medical science is poised on the threshold of a new era of research breakthroughs. Using the powerful new tools of biotech-

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An Old Idea Heats Up

The ancient Greeks understood the concept: excessive heat kills living tissue. But it wasn't until modern technology developed the proper tools that scientists were able to put the concept of hyperthermia to work on behalf of humans and animals.

"Heat sensitizes tumor cells to other forms of therapy, such as radiation," says Dr. Ed Gillette, director of the comparative oncology program at Colorado State University's College of Veterinary Medicine.

Dr. Gillette and his colleague, Dr. Stephen Winthrow, used localized heat and radiation on spontaneously occurring oral carcinomas in dogs. They found improved local tumor control at well-tolerated doses of radiation. Just as important, the heat didn't increase the frequency of complications.

"Our goals are to optimize the therapeutic impact on the tumor and to minimize the deleterious impact on healthy tissue," Dr. Gillette explains. "We had better results using radiation in combination with hyperthermia than with radiation alone."

The localized hyperthermia project is one of six components of Dr. Gillett's prestigious program project grant from the National Cancer Institute (NCI). Now in its seventh year, it is one of the few program projects funded by the NCI at veterinary schools.

"The thesis behind a program project is that the results of a coordinated series of projects will be greater than the output of separately funded and administered projects," Dr. Gillette explains. "We collaborate with the veterinary school at North Carolina State University, the medical school at Duke University, and with a medical epidemiologist at Western Ontario University."

At NC State, Dr. Don Throll and his associates are studying the effects of whole-body hyperthermia on bone cancer in dogs. Their objective is to reduce the need to amputate limbs.

"We're evaluating the toxicity of whole-body hyperthermia alone, then in combination with chemotherapy and with radiation," Dr. Thrall reports. "Our cooperators at the Duke medical school are using the same procedure to evaluate the effects of local and regionalized hyperthermia."

Using spontaneously occurring tumors in dogs allows these researchers to be much more aggressive with experimental protocols and to obtain useful results in a shorter period of time.

"Our goal is to help design more efficient human clinical trials and thereby hasten the application of these promising new therapies to humans," Dr. Gillette says. "In the meantime, we're giving the dogs in these studies—who are people's beloved pets, after all—the best that medical science has to offer."

nology and information processing, veterinary medicine faces a virtually unlimited horizon of promising avenues of research.

Biotechnology has its origins in the early 1970s, when major advances in molecular biology showed that genes could be subdivided and recombined in different ways. Early studies with recombinant DNA were supplemented by work with directed mutation and recombinant RNA. The cloning of animal, plant, and microbial tissues and the culture of individual cells and protoplasts are important technologies that complement genetic engineering.

These techniques enable researchers to benefically alter organisms to obtain desired heritable characteristics, such as disease resistance and improved growth. Veterinary medical scientists are using these technologies to develop new generations of diagnostic tools and vaccines that promise to eliminate many of the diseases afflicting humans and animals.

Moreover, recent advances in micro- and minicomputers, computer networking systems, and software development have given scientists the tools they need to improve the efficiency and effectiveness of research and development projects. Among the many veterinary applications is the development of comprehensive, networked data bases on important diseases, with easy access for researchers, practitioners, and producers alike. Equally important is the development of computer-based management systems for livestock production which integrate health, economic, environmental, and management data to reduce losses from disease, to improve productivity, and to increase profitability.

Biotechnology is providing new tools for solving human and animal medical problems. Here, researchers at the University of Tennessee's College of Veterinary Medicine are sequencing a gene to be used in a recombinant-DNA vaccine for pig scours. (Photo courtesy of the University of Tennessee)

Biotechnology and computer networking offer unparalleled opportunities for advances in veterinary medical research, and the nation's 27 colleges and schools of veterinary medicine are uniquely positioned to take advantage of these new tools.

An Untapped Resource

The university-based veterinary medical research community has the foundation to take full advantage of these challenging opportunities. With their multidisciplinary education, problem-solving ability, and knowledge of animals, veterinary medical scientists are able to see connections and implications that often lead to unanticipated solutions and spin-off benefits. Moreover, the nation's 27 colleges and schools of veterinary medicine are uniquely positioned to support the work of these scientists.

- Most veterinary schools are located at land-grant universities, and their ties to agriculture—with academic departments, extension agents, and producers—offer opportunities to pursue integrated research programs and demonstration projects.
- Preclinical departments in veterinary schools provide a strong foundation for fundamental biomedical research.

- Many institutions also have outstanding medical schools and teaching hospitals, which offer unparalleled opportunities for collaborative research.
- Veterinary school faculties have access to a wealth of clinical materials which are valuable for long-range studies, present challenging new problems for investigation, and offer opportunities to put research to work for the direct benefit of animals and their owners.

Faculty members in veterinary science departments also make special contributions. Without teaching and clinical responsibilities in a veterinary degree program, most are able to concentrate almost entirely on research and graduate education. Their commitment to research has led to major funding from external agencies. Moreover, because veterinary science departments normally are part of agriculture colleges, their faculty often have direct access to federal Hatch funds through their Agricultural Experiment Stations.

In essence, veterinary medical research is a virtually untapped resource with tremendous potential to achieve significant results. A substantial public investment in this resource is needed to realize its full potential.

Computers Help Solve Production Problems

To most farmers, parity means the price they can receive for their products through federal support programs. To pig farmers, however, the term has another meaning that's even more important to the profitability of their operations—how many times their sows can farrow, or have a litter of young.

Pig farmers in the Midwest had recognized that their sows were having lower-than-expected farrowing rates (pigs/sow/year). Now, with the help of a sophisticated, computer-based herd health program, they're able to pinpoint the problem and develop some solutions.

"Analyzing the data from our computerized swine health program, Pig Champ, we were able to see that the problem was most evident in parity #2—the second time of giving birth," reports Dr. Tom Stein, developer and director of the program at the University of Minnesota's Swine Center. "From this, we were able to study some possible solutions. We found that weaning the sows at four weeks rather than three and allowing them to skip a heat period before breeding again after their first litters increased their farrowing rates."

Clarifying problems and developing solutions is what Pig Champ is all about. Development of the sophisticated software began in 1982 when administrators and faculty at Minnesota's College of Veterinary Medicine recognized that computerized herd health programs were the wave of the future. Initially supported by internal college funds, Pig Champ now includes 3-4,000 herds around the world and is totally self supporting.

While other herd-health software programs exist, Pig Champ is the only "stand alone" system, meaning producers input the data on their own personal computers and retrieve information independent of the college's Swine Center. Veterinarians from the Center are available to help producers interpret the results, but most soon learn to use the system on their own.

In addition to helping swine producers increase productivity and profitability, Pig Champ also supports an active research program at the Center.

"The program is sold to producers at a lower cost if they agree to allow us to use their information for research," explains Dr. Carlos Pijon, director of the college's swine medicine group. "The system allows us to analyze data on a large number of animals, approximately 8,000 litters each year."

In its early stages, the program was limited to reproduction data, and researchers investigated problems such as the low farrowing rates. Now Pig Champ has been expanded to include work on parvovirus, pseudorabies, pneumonia, and many other swine health problems.

"We're analyzing production data to identify the causes of suboptimal production," Dr. Pijon reports. "This information is fed into our ongoing research program. The results from those studies are, in turn, shared with the producers. It's a mutually beneficial system."

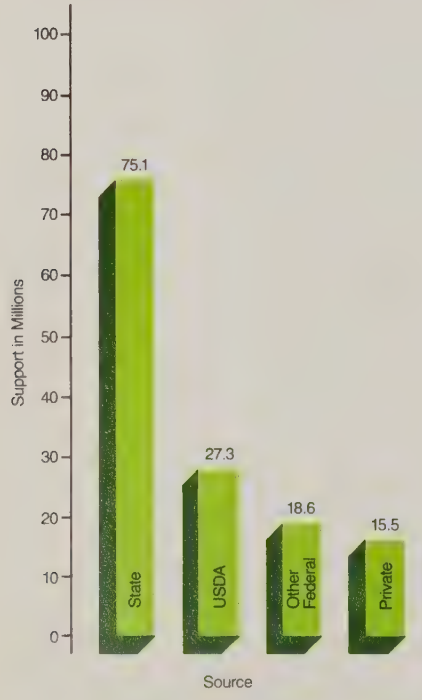
Resources for Veterinary Medical Research

Productive research programs require more than creative people and promising ideas: they require money. Stable, long-term funding is needed to support the personnel and laboratories that form the foundation of any scientific enterprise, while special, short-term funds allow these scientists to exploit emerging research opportunities.

Current funding for university-based veterinary medical research is nearly as diverse as the research itself. Figure 4 shows funding for **food-animal research alone** in fiscal year (FY) 1985. If funds for animal-model research were included, the total for non-USDA federal funding would be substantially higher.

Figure 4.

Funding for Food-Animal Health Research, FY 1985



State and Private Support

State governments have long recognized the importance of veterinary medical research and have provided a significant portion of its total support through general legislative appropriations and targeted grants for specific research projects. Together with federal formula funds, state funds provide the essential core of support for research facilities, equipment, and people. This stable funding, which exceeded $75.1 million in FY1985, enables universities to respond to the needs of the tax-paying citizens they serve. In addition, some state departments of agriculture and public health offer extramural grants for research on state and local problems for which they do not have internal expertise.

The private sector also provides support for veterinary medical research, with nearly $15.5 million invested in FY1985. Agricultural and pharmaceutical companies offer grants and cooperative research contracts to university scientists for studies related to their products. And, increasingly, sources of private venture capital are establishing joint enterprises with universities and/or their scientists to develop and market products resulting from basic academic research.

Some private foundations and organizations provide grants for veterinary medical research, particularly as it pertains to companion animals. Indeed, such grants, along with contributions from individual pet owners, currently represent the sole source of support for companion-animal research that is not specifically directed toward solving human medical problems.

Federal Support

At the federal level, the National Institutes of Health fund veterinary medical research related to human medical problems. Awarded on a competitive, peer-review basis, such grants support research projects on the cutting edge of medical science, which most often involve the use of the latest biotechnologies. In FY1985, NIH support exceeded $7 million for food-animal health research alone. A figure for NIH-supported animal-model research is not available, but is much higher.

The NIH also supports training grants, which provide stable, long-term funding for graduate and post-graduate education in the biomedical sciences. Such grants are a critical element in developing efficient, productive research teams focusing on specific biomedical issues. Some veterinary medical research laboratories currently have NIH training grants, and this source of funds needs to be expanded.

A major public investment in both formula funds and competitive grants is needed to enable veterinary medical scientists to pursue promising new avenues of research for the benefit of people, animals, and the environment.

Increased public support for all types of veterinary medical research will produce tangible benefits for humans and animals alike.

Other federal agencies, such as the National Science Foundation (NSF) and the Department of Defense, fund some aspects of veterinary medical research through their competitive-grants programs and cooperative research agreements. In FY1985, these funds totaled more than $11.7 million for research related to food animals.

The USDA plays a central role in funding university-based animal health and disease research through programs administered by its Cooperative State Research Service (CSRS).

- The Food and Agriculture Act of 1977 (P.L. 95-113) established the Animal Health and Disease Research Program (commonly referred to as Section 1433), a formula-based funding program directed toward improving the health and productivity of livestock animals and protecting human health by controlling food-animal diseases transmissible to humans. These formula funds provide the continuity essential for productive research programs.
- P.L. 95-113 also authorized the Animal Health Special Research Grants Program (Section 1414 (c)(1) amending P.L. 89-106), which funds competitive grants that emphasize the solution of high-priority, nationally important problems. Special Research Grant awards are made in a peer-review process and provide a focus for innovative approaches to fundamental problems in animal health.
- The USDA also supports animal health research through its Hatch Act program, a strong formula-funded program for agricultural research administered at the local level and addressing local problems.
- Some funds for food-animal health research are available through the Evans-Allen Program, which was initiated in 1967 to support agricultural research at the land-grant colleges of 1890 and Tuskegee Institute (now Tuskegee University).
- Animal health research also receives some funds through the Competitive Research Grants

Catfish production is a $750-million-year industry in Mississippi, a state with over 90,000 surface-acres in commercial catfish ponds. Veterinary medical scientists at Mississippi State University are working on several problems faced by the industry, including winter kill and contamination by algal by-products which destroy the flavor of the fish and make them unmarketable. (Photo courtesy of Mississippi State University)

Program in biotechnology administered by the USDA's Office of Grants and Program Systems.

USDA support for food-animal health research through all of its funding mechanisms has remained essentially static in recent years. Indeed, when the effects of inflation and higher research costs are taken into account, the purchasing power of USDA support has actually decreased substantially.

- Section 1433 formula funding was only $5.476 million in FY1987, contrasted to an estimated **$5 to $7 billion in annual losses** to the animal agriculture industry from disease.
- Funding for Animal Health Special Research Grants **declined in actual dollars** in FY1987, and only 16 percent of the competitive proposals have been funded over the 9 years of the program.
- In FY1987, **only 6 percent** of the Hatch formula-fund budget—about $9 million—was allocated to support animal health research, and only one-third of this amount went directly to colleges and schools of veterinary medicine.
- Funding of food-animal health research from the Evans-Allen Program was only $173,000 in FY1985, **severely limiting the ability of faculty at these pre-**

dominantly black colleges to develop successful research programs.

- **Only $3.925 million** of the $18 million appropriated in FY1987 for the Competitive Research Grants Program in biotechnology was awarded for projects related to food-animal health.

Future Needs

Modern veterinary medical research is expensive. It costs a great deal of money to train professionally qualified scientists and technicians, to equip laboratories with technologically sophisticated equipment, to construct or renovate facilities that can accommodate contemporary research, and to adequately house and care for experimental animals. Clearly, **each of the many sources of funding must be increased significantly** if veterinary medical research—the nation's untapped scientific resource—is to reach its full potential. Four types of funding are critically needed:

- Training grants specifically designed to provide post-professional training are essential if veterinary medical scientists are to develop nationally respected biomedical laboratories and successfully compete for peer-reviewed grants. Such training grants would help attract top veterinary graduates to careers in research and thereby ensure a continuing source of highly skilled veterinary medical scientists.
- Funds appropriated for the USDA's Animal Health and Disease Research Program (Section 1433) must be increased over the

"Powerful Program" Leads to Post-Doc

For more than two decades, the School of Veterinary Medicine at the University of Pennsylvania has provided a unique opportunity for veterinary students to pursue careers in biomedical science. Through a six-year program leading to both a professional degree in veterinary medicine and a doctorate in a basic science, students are able to combine their clinical experience with in-depth training in a biomedical specialty.

The Veterinary Medical Scientist Training Program solved a dilemma for Dr. Leslie McGregor, now a postdoctoral fellow at the Harvard Medical School.

"I knew I wanted a career in medical research," she recalls, "but I didn't know whether I should get a veterinary degree or a PhD. With the program at Pennsylvania, I was able to do both."

While working on her VMD, as Pennsylvania calls its veterinary degree, Dr. McGregor did her PhD research on the intermediary metabolism of diabetes in a biochemistry lab in the University's medical school. She believes the program was good preparation for her current research on the metabolic defects that cause blindness in diabetics.

"To understand disease processes, you need a medical education—either an MD or a VMD," she says. "My veterinary education was very comprehensive and gave me an excellent background for whatever medical topic I wanted to study.

"I also received valuable training in my PhD program," she adds. "I had to present my work at research seminars, and I was involved in writing grant proposals."

Some of the positions in the Veterinary Medical Scientists Training Program are funded by a training grant from the National Institutes of Health (NIH). The grant covers all educational costs and provides a modest stipend. Dr. McGregor says this support was crucial to her subsequent career.

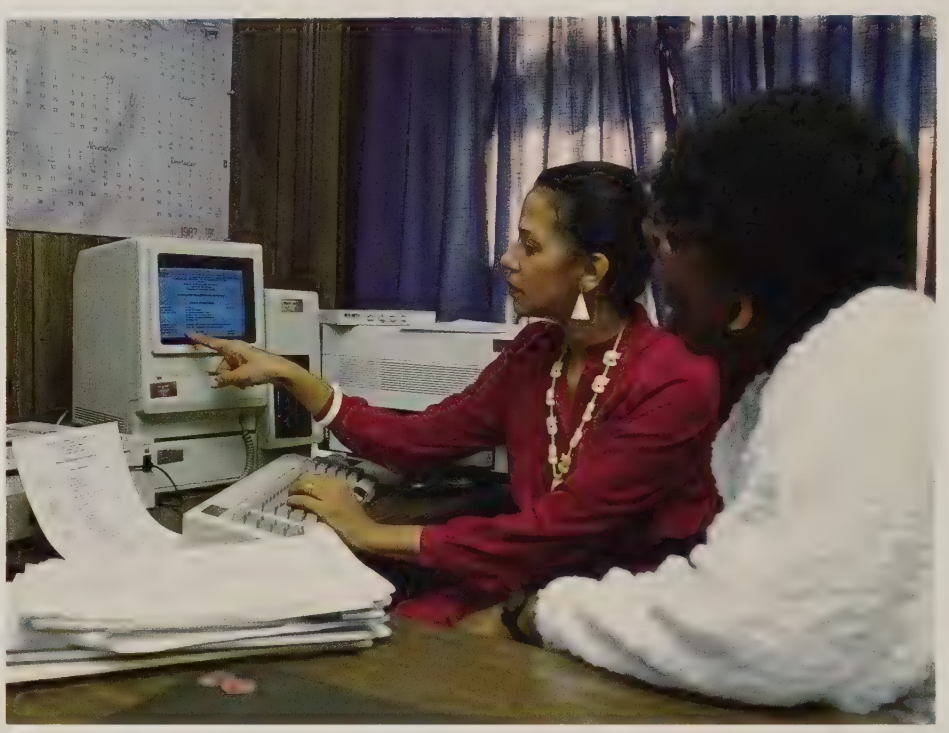
"If I had not been supported, I could not be a post-doc fellow now," she says. "I didn't have the usual debt coming out of veterinary school, so I was able to accept a fellowship for postgraduate study rather than looking for a salaried position."

Dr. McGregor's career choice was reinforced through this combined educational experience, and she would recommend such a program to anyone interested in biomedical research.

"I've gotten involved in pure research," she says, "but I still use my clinical skills everytime I work with animals. This type of program is very powerful because of the interaction you have with the other medical schools and academic departments."

next five years to reach the original allocation ceiling of $25 million authorized by Congress. Concurrently, state funds required to match the Section 1433 formula funds also must be increased. Without such increases in their funding base, university research administrators cannot undertake long-range planning nor assure local livestock producers that they are capable of providing solutions to animal disease problems that threaten the producers' livelihoods. The level and proportion of Hatch and Evans-Allen funds allocated for animal health research also need to be increased.

- Funds for federal competitive-grants programs, especially those administered by the USDA, should be increased substantially. Such programs represent the nation's investment in the leading edge of biomedical science and technology, an investment that is essential if the United States is to stay competitive, let alone retain a leadership role, in today's global economy. In particular, funding levels for the USDA's Special Research Grants Program must be increased to the original level authorized, $10 million, with annual increases to reflect inflation. The current $150,000 ceiling for individual grants should be raised to $250,000. Moreover, funding for the Competitive Research Grants Program administered by the USDA's Office of Grants and Program Systems should be increased substantially so that funds available for animal health projects also can be increased.



Advanced computer technology is helping veterinary medical scientists to develop data bases on animal diseases and livestock production systems and to more readily share this information with users. An outstanding example of this process is the Biomedical Information Management System at Tuskegee University. (Photo courtesy of Tuskegee University)

- A mechanism for providing public funds for companion animal research needs to be established. The majority of households in the United States include one or more pets. These animals make a significant contribution to the quality of life for American families. It is reasonable, therefore, that public funds be allocated to enhance this aspect of the quality of life for these tax-paying citizens—just as public funds are used to promote the cultural aspects of the American way of life. A federal competitive-grants program would provide much-needed support for research directed at promoting the health and prolonging the lives of companion animals. If history is any judge, much of this research, though directed for the animal's sake, will result in spin-offs that enhance human health and well-being as well. Indeed, a specific area of research funded by such a program could be further investigation of the effect of the human-animal bond on human health and longevity.

Veterinary Medical Research Priorities

Given adequate resources, veterinary medical scientists can exploit the new advances in biotechnology and information processing for the benefit of humans, animals, and the environment. Research priorities have been identified for each of the areas of veterinary medical research.

Ensuring a nutritious, safe, and affordable food supply

Decreasing margins of profitability in livestock operations have made economic and production efficiency increasingly important. At the same time, advances in communications technology have made possible the development of computer-based information systems that can integrate data on nutrition, health, environmental conditions, management practices, and economic considerations. Much basic research needs to be done, however, on each of these factors, as well the interactions among them, so that effective integrated livestock management systems can be developed and the continuing supply of quality food products can be assured. In particular,

Veterinary medical scientists are dedicated to ensuring a nutritious, safe and affordable food supply; improving human health and longevity; and enhancing the quality of life.

A combination of modern production practices and improved disease prevention programs result in the economical marketing of more than 4.3 billion healthy broilers and 1.75 million healthy turkeys each year. (Photo courtesy of the University of Georgia)

- A systems approach to the basic mechanisms of disease needs to be implemented. Such an interspecies approach could reduce the cost of solving specific disease problems and expedite control of similar diseases in various species.
- The effects of environmental factors—such as temperature, ventilation, water supply, excreta removal, crowding, and toxin accumulation—on animal health and productivity need to be identified. Few studies have quantified these effects or calculated the cost effectiveness of maintaining optimum environmental conditions for domesticated animals.
- Further research also is needed to devise strategies for effectively implementing computer-based livestock management systems in actual production units, as well as to determine optimal delivery systems for veterinary medical care in modern livestock operations.
- Much work needs to be done on devising efficient aquaculture systems to make more extensive use of this valuable source of low-cholesterol protein and other nutrients.

Improving human health and longevity

The possibilities for effective application of biotechnologies to the prevention, diagnosis, and cure of significant human diseases are

(Continued on page 21)

Cats and AIDS: The Circle Closes

"What goes around, comes around," according to Dr. Niels Pedersen, professor of medicine at the University of California's School of Veterinary Medicine in Davis. And he should know.

Dr. Pedersen has been working on viral diseases of cats since the 1960s. At that time, he says, many animal diseases, including cancer, were known to be caused by viruses, but few similiar diseases had been identified in humans. Dr. Pedersen and his colleagues were particularly interested in a class of viruses called retroviruses, one of which causes feline leukemia. They made great strides in understanding the pathogenesis of this deadly disease.

"However, by the late 1970's," he reports, "the emphasis in human oncology turned to carcinogens—chemicals in food and the environment that cause cancer—and funds for viral oncology began to dry up."

Enter the AIDS epidemic.

AIDS—Acquired Immune Deficiency Syndrome—had all the hallmarks of retrovirus diseases such as feline leukemia, so scientists searching for the cause knew where to begin looking. "All the earlier work on retroviruses made it possible to identify the AIDS virus so rapidly," Dr. Pedersen says.

When the AIDS virus was identified, it turned out to be from a different subfamily known as lenti viruses. These viruses cause chronic disease syndromes in livestock, but had not previously been thought to be important in human disease.

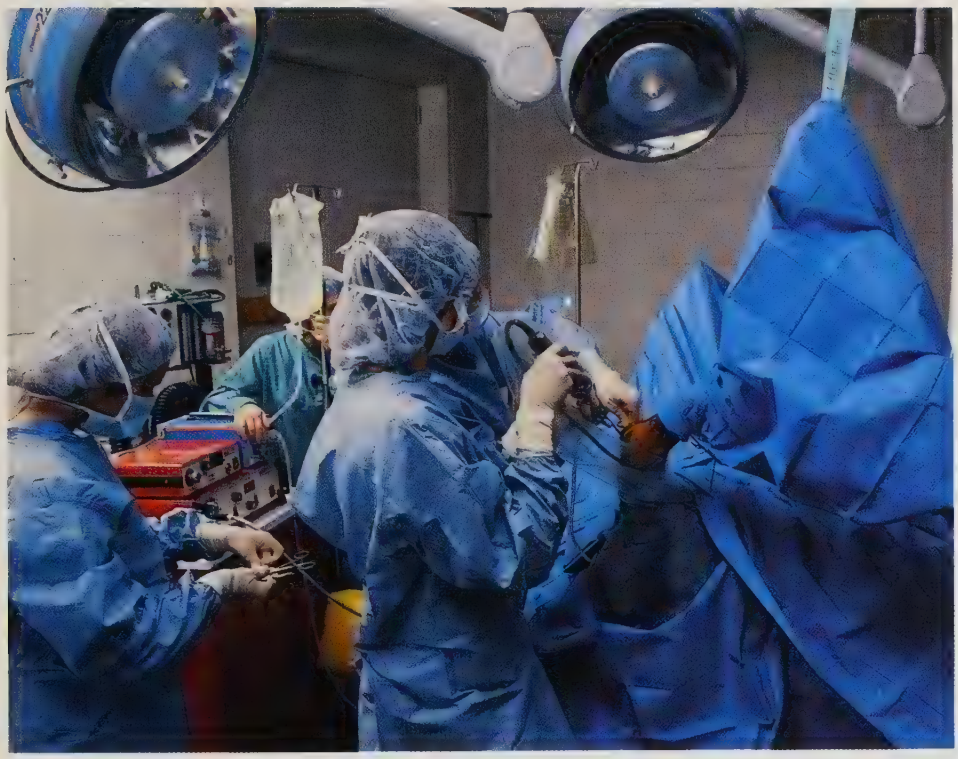
As a result of the AIDS research, Dr. Pedersen began studying cats that had AIDS symptoms, but had tested negative for the feline leukemia virus. In January 1987, he and his colleagues published a report in *Science* identifying the first "AIDS" virus in cats—T-lymphotropic lenti virus, which is genetically similar to the human AIDS virus.

"The pathogenesis of this disease is remarkably similar to human AIDS," Dr. Pedersen says. "These cats develop chronic infections of the skin, mouth, respiratory and intestinal tracts. They're susceptible to opportunistic infections, and some develop neurological disease. They can be kept alive for years with supportive therapy, but eventually the immune system totally breaks down and they die."

Dr. Pedersen's research has led to the development of a test to identify the disease. Equally important, cats naturally infected with this virus are being used as models to study the pathogenesis of AIDS and to develop effective drug therapies and vaccines for humans.

"So the circle has closed," he notes. "The early work we did on animal diseases helped with the understanding of AIDS, and the AIDS research has helped us understand an animal disease.

"The moral of the story, so to speak, is that there's only one medicine," Dr. Pedersen says. "Humans and animals suffer from many of the same diseases. Human disease research benefits animals, and vice versa. Advances in any kind of biomedical research benefit us all."



Many surgical techniques that benefit humans, such as this arthroscopic joint surgery, were first perfected on animals and benefit them as well. (Photo courtesy of North Carolina State University)

limitless. More traditional research methodologies also will continue to yield results that benefit human health and well being. Among the many threats to human health to which veterinary medical research is applicable, the top priorities include:

- **AIDS and other viral diseases.** Veterinary medical research was instrumental in identifying the virus that causes Acquired Immune Deficiency Syndrome, which afflicts over 50,000 people in the United States alone. The epidemic spread of this devastating disease makes further research on promising therapies and vaccines imperative.
- **Cardiovascular disease.** Heart attacks are the leading cause of death in the United States, striking 1.5 million each year, 540,000 fatally. Surgical therapies that prolong thousands of lives, such as by-pass operations, were first perfected on laboratory animals. Further research is needed on new, less-invasive procedures that have potential for saving even more lives.
- **Cancer.** Cancer touches the lives of 1 out of every 3 people in this country. All kinds of cancer common in humans are recognized in animals. Remarkable progress has been made in understanding the causes and progression of this disease, and research using induced and spontaneously occurring tumors in animals is leading the way.
- **Neurologic disorders.** The American population is growing older: demographic studies predict that by the year 2000, more than 34.9 million Americans will be over 65 years old. The emotional and economic costs of diseases that afflict the elderly, such as Alzheimer's, will increase accordingly. Veterinary medical scientists can play an important role in helping reduce this suffering and financial burden.
- **Genetic and developmental defects.** Using the powerful tools of biotechnology, molecular biologists are making great strides in understanding the fundamental workings of the genome and how normal development can be disturbed. These same tools are allowing researchers to develop promising strategies for preventing or correcting genetic "mistakes." With their training in comparative medicine, veterinary scientists can make important contributions to these efforts.

Enhancing the quality of life

Americans are both the creators and beneficiaries of one of the highest standards of living in the world. Blessed with abundant renewable resources, a stable and democratic political process, and a resilient economic system, Americans have the

freedom to direct their efforts to maintaining and improving their natural environment, their community assets, and their personal lives. Veterinary medical research has direct effects on each of these areas, with the following important priorities:

- Companion animals promote the mental health and happiness of millions of Americans. Much research needs to be done to conquer the diseases, such as feline leukemia and canine parvovirus, that prematurely claim the lives of these beloved pets.
- The human-animal bond needs to be better understood and its implications for the use of animals in institutional settings— such as nursing homes, hospitals, and prisons— needs to be further investigated.
- Zoos, aquariums, and wildlife parks are valuable community resources. Research is needed to improve their physical facilities and management to ensure the health, behavioral integrity, and longevity of captive species. Such facilities also need funding for further research on successful breeding techniques for endangered species.
- Veterinary medical scientists play a vital role in studies designed to protect and enhance wildlife habitat and improve management programs for wild populations. Much more needs to be done in this area to balance the needs and desires of sportsmen and environmentalists.
- Certain wild species, such as raptors and fish, serve as sensitive indicators of environmental contamination. Further research is necessary to develop accurate and efficient monitoring systems that provide early warning of threats to the natural environment, the food supply, and human health.

Through the People-Pet Partnership Program at Washington State University's College of Veterinary Medicine, Handsome, the cat, helped this stroke victim overcome her disabilities and enjoy the remaining years of her life. (Photo courtesy of Washington State University)

With their interdisciplinary orientation, scientific resources, and vast knowledge of animals, including man, university-based veterinary medical scientists are making significant contributions to ensuring an adequate food supply, improving human health, and enhancing the quality of life. With increased public and private investments, existing projects can be accelerated, additional researchers can be trained, and new initiatives can be launched to build on this cornerstone for healthy life and for the betterment of society.

U.S. Colleges and Schools of Veterinary Medicine

Auburn University
College of Veterinary Medicine
Auburn, Alabama

University of California
School of Veterinary Medicine
Davis, California

Colorado State University
College of Veterinary Medicine
Ft. Collins, Colorado

Cornell University
New York State College of
Veterinary Medicine
Ithaca, New York

University of Florida
College of Veterinary Medicine
Gainesville, Florida

University of Georgia
College of Veterinary Medicine
Athens, Georgia

University of Illinois
College of Veterinary Medicine
Urbana, Illinois

Iowa State University
College of Veterinary Medicine
Ames, Iowa

Kansas State University
College of Veterinary Medicine
Manhattan, Kansas

Louisiana State University
School of Veterinary Medicine
Baton Rouge, Louisiana

Michigan State University
College of Veterinary Medicine
East Lansing, Michigan

University of Minnesota
College of Veterinary Medicine
St. Paul, Minnesota

Mississippi State University
College of Veterinary Medicine
Mississippi State, Mississippi

University of Missouri
College of Veterinary Medicine
Columbia, Missouri

North Carolina State University
School of Veterinary Medicine
Raleigh, North Carolina

Ohio State University
College of Veterinary Medicine
Columbus, Ohio

Oklahoma State University
College of Veterinary Medicine
Stillwater, Oklahoma

Oregon State University
College of Veterinary Medicine
Corvallis, Oregon

University of Pennsylvania
School of Veterinary Medicine
Philadelphia, Pennsylvania

Purdue University
School of Veterinary Medicine
West Lafayette, Indiana

University of Tennessee
College of Veterinary Medicine
Knoxville, Tennessee

Texas A & M University
College of Veterinary Medicine
College Station, Texas

Tufts University
School of Veterinary Medicine
North Grafton, Massachusetts

Tuskegee University
School of Veterinary Medicine
Tuskegee, Alabama

Virginia Polytechnic Institute and
State University
Virginia/Maryland Regional
College
of Veterinary Medicine
Blacksburg, Virginia

Washington State University
College of Veterinary Medicine
Pullman, Washington

University of Wisconsin
School of Veterinary Medicine
Madison, Wisconsin

U.S. Departments of Veterinary Science and Animal Science*

University of Arizona
Department of Veterinary Science
Tuscon, Arizona

University of Arkansas
Department of Animal Science
Fayetteville, Arkansas

University of Connecticut
Department of Pathobiology
Storrs, Connecticut

University of Delaware
Department of Animal Science and Agricultural Biochemistry
Newark, Delaware

University of Hawaii
Department of Animal Science
Honolulu, Hawaii

University of Idaho
Department of Veterinary Science
Moscow, Idaho

University of Kentucky
Department of Veterinary Science
Lexington, Kentucky

Louisiana State University
Department of Veterinary Science
Baton Rouge, Louisiana

University of Maine
Department of Animal and Veterinary Sciences
Orono, Maine

University of Maryland
Department of Veterinary Science
College Park, Maryland

University of Massachusetts
Department of Veterinary and Animal Sciences
Amherst, Massachusetts

Montana State University
Veterinary Research Laboratory
Bozeman, Montana

University of Nebraska
Department of Veterinary Science
Lincoln, Nebraska

University of Nevada
Division of Veterinary Medicine/ Department of Veterinary Science
Reno, Nevada

New Mexico State University
Department of Animal and Range Sciences
Las Cruces, New Mexico

North Dakota State University
Department of Veterinary Science
Fargo, North Dakota

Ohio State University
Food Animal Health Research Program
Wooster, Ohio

Pennsylvania State University
Department of Veterinary Science
University Park, Pennsylvania

University of Rhode Island
Department of Animal and Veterinary Sciences
Kingston, Rhode Island

Rutgers—The State University
Department of Animal Science
New Brunswick, New Jersey

South Dakota State University
Department of Veterinary Science
Brookings, South Dakota

Utah State University
Department of Animal, Dairy, & Veterinary Sciences
Logan, Utah

West Virginia University
Division of Animal and Veterinary Sciences
Morgantown, West Virginia

University of Wisconsin
Department of Veterinary Science
Madison, Wisconsin

University of Wyoming
Department of Veterinary Science
Laramie, Wyoming

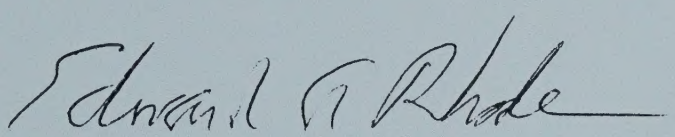
*Only those departments that receive federal animal-health research funds are listed.

Acknowledgments

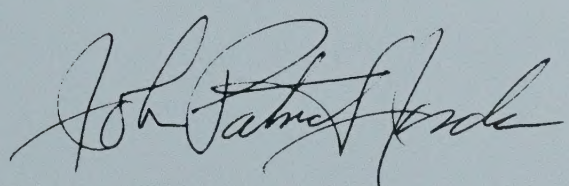
This document is the result of a cooperative effort between the Association of American Veterinary Medical Colleges (AAVMC) and the Cooperative State Research Service (CSRS) of the United States Department of Agriculture.

The project was directed by Dr. Hyram Kitchen, dean, College of Veterinary Medicine, University of Tennessee; Dr. Terry Curtin, dean, School of Veterinary Medicine, North Carolina State University; and Dr. Robert Anderson, dean, College of Veterinary Medicine, University of Georgia. Funds for the project were provided by CSRS and AAVMC and administered by Dr. Billy Hooper, executive director, AAVMC, and Dr. Daryl King, principal veterinarian, CSRS. The report was developed and written by Susan Reardon of WordWorks, S.P., and designed and illustrated by Riverhouse Graphics.

Special thanks for providing essential information and reviewing drafts of the report go to Drs. Kitchen, Curtin, Anderson, Hooper and King and to the scientists profiled in the document.



Dr. Edward Rhode, President
Association of American
Veterinary Medical Colleges



Dr. J. Patrick Jordan, Administrator
Cooperative State Research Service
U.S. Department of Agriculture